

Before the Storm: A Potential Role for Dry Weather in Children's Risk of Diarrhea

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<https://doi.org/10.1289/EHP6135>

Diarrheal diseases are the second leading cause of death of young children worldwide, according to the World Health Organization.¹ Recurrent and prolonged episodes of diarrhea in childhood are also associated with malnutrition, stunted growth, and impaired cognitive development.² A recent study reported in *Environmental Health Perspectives* investigates climate-related variables and risk of diarrhea among children in rural Tamil Nadu, India.³

Diarrheal diseases—which can be spread through contaminated food or drinking water or from person to person through poor hygiene. These diseases are seasonal in many locations.⁴ Previous studies have found that both high temperatures and heavy rainfall may be linked to greater diarrhea risk in low-income countries.⁴ Most previous studies on the relationship between temperature, rainfall, and diarrhea risk in low-income countries have focused on groups that drink water from surface sources such as springs, rivers, and lakes.

“Surface water may be more prone to bacterial contamination than groundwater,” says lead study author Andrew Mertens, a PhD candidate in epidemiology at the University of California, Berkeley. Yet in rural South India, where Mertens worked on sanitation and nutrition, hundreds of millions of people rely on groundwater, which is extracted through tube wells and drawn

into tanks that resemble miniature water towers. The stored water is distributed via communal standpipes.

Mertens and colleagues wanted to assess whether hot weather and heavy rain contributed to child diarrhea risk in villages with this type of groundwater drinking source. In a prospective cohort of children under 5 years of age from 25 villages in Tamil Nadu, the researchers collected information on weather and reports of diarrhea within the preceding 7 days (i.e., the recall period) for each month between January 2008 and April 2009. The cohort included 1,284 children from 900 households.

The researchers recorded a total of 259 cases of diarrhea over the time period. Diarrhea risk was 2.95 times greater when the average temperature in the week before the recall period was in the hottest versus the coolest quartile of average weekly temperatures over the study period. Diarrhea prevalence also increased after heavy rainfall events, defined in this study as at least 1 day with more than 16.82 mm (0.66 in) of rain—the 80th percentile for precipitation on days with any rain. The risk of diarrhea was 1.5 times greater when the 3 weeks before the recall period included 1 or more days of heavy rainfall and 2.6 times greater when this heavy rainfall followed a 60-day dry period.



The results of a new study suggest that drinking contaminated water is not the primary route by which children in rural Tamil Nadu contract diarrheal diseases. Instead, heavy rainfall may flush contaminants into human contact by other pathways. Image: © LEBLOND Catherine/Alamy Stock Photo.

“These findings support the idea that it is important to look at the conditions before the rain event in addition to the rain event itself when assessing diarrhea risk,” says Karen Levy, an epidemiologist at Emory University who was not involved in the study. The results are consistent with those of a 2014 study in Ecuador that associated heavy rainfall with increased diarrhea incidence following dry periods but a reduction in diarrhea incidence with heavy rainfall following a wet period.⁵

Under dry conditions, contaminants may accumulate in the environment, staying put until mobilized by heavy rainfall. This phenomenon, known as first flush, has been studied extensively in relation to urban runoff of chemicals and water quality, explains Levy. “Here we see that principle applied to microbial contaminants,” she says.

While groundwater is thought to be a more protected source than surface water, several studies have linked diarrheal disease outbreaks in both low- and high-income countries to rainfall-driven groundwater contamination.^{6,7} It is unclear what the new findings mean in the context of climate change, says Mertens, who also cautions against generalizing the results of the study to other locations. “Water, hygiene, the dominant pathogens causing diarrhea, and what is considered ‘heavy’ rainfall are likely to differ between regions,” he says.

Although this study did not examine routes of infection other than drinking water, where only a small increase in markers of bacterial contamination occurred after heavy rain, future studies to identify causal pathways could lead to effective, low-cost interventions, says Mertens. “If the primary pathway is contamination of the drinking water source, we’d want to implement better water infrastructure or treat with chlorine,” he explains. “But if

the primary pathway is playing in a muddy courtyard after heavy rain, the intervention may look quite different.”

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